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WAR DEPARTMENT

TECHNICAL MANUAL

INSTRUCTION GUIDE

PLOTTING BOARD M5

March 14, 1942

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INSTRUCTION GUIDE

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SECTION I

GENERAL

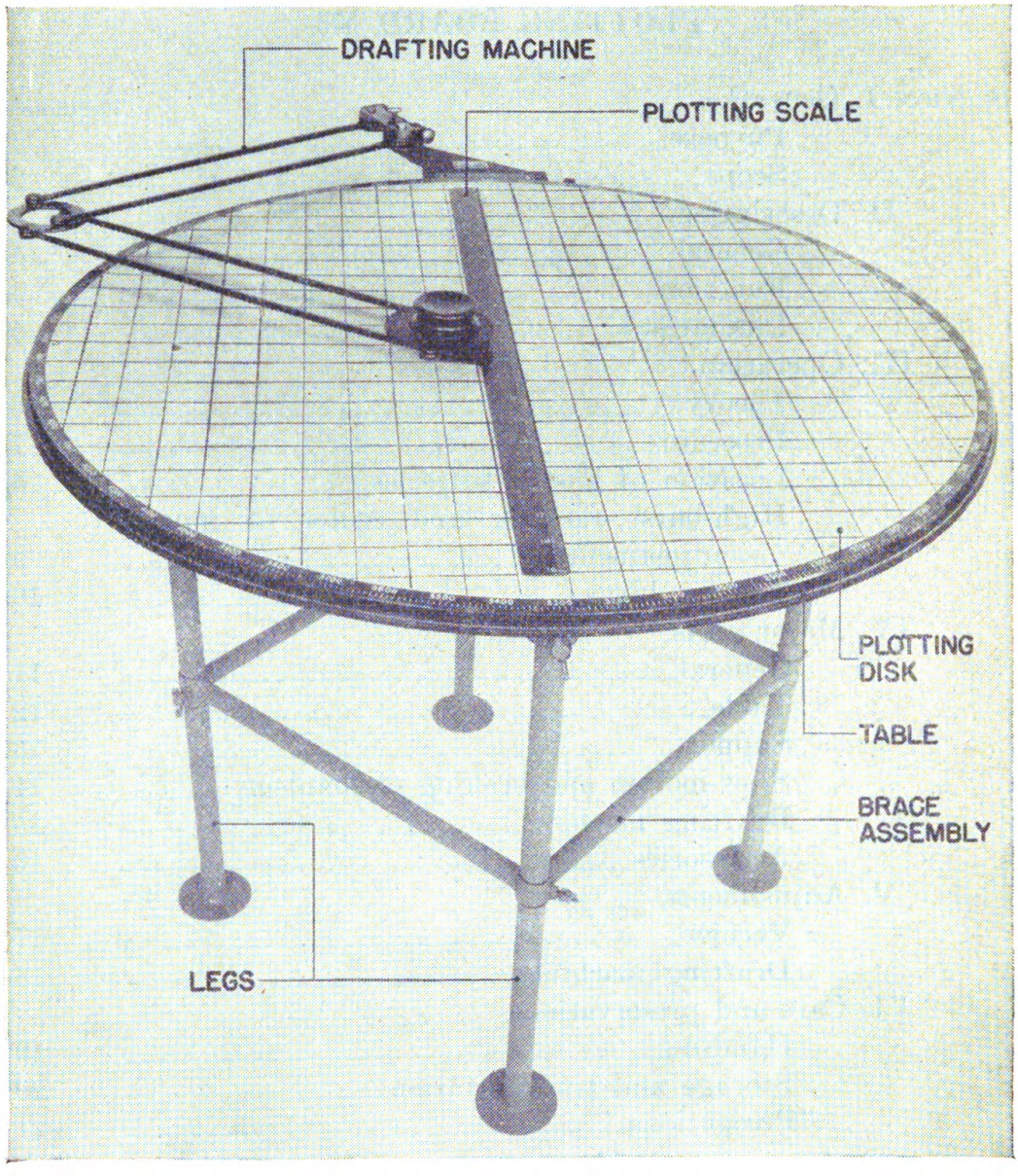

FIGURE 1.—Plotting board M5.

1. Purpose.—This manual is published for the information of both the using arms and services and ordnance maintenance personnel.

2. Scope.—This manual covers the theory of the plotting board M5, a general description of the instrument, and complete instruc-

tions for its operation, care, and maintenance. Maintenance operations described herein may be performed by using arms personnel.

SECTION II

DESCRIPTION

3. General.—*a.* The plotting board M5, formerly known as the flash ranging plotting board M5, consists of a rotating table with a grid engraved upon its top surface, a drafting machine with a graduated straightedge attached, and the necessary supporting base and legs.

b. An azimuth scale in mils is graduated on the periphery of the top surface of the table, and a vernier scale providing a least reading of ½ mil is attached to the bracket to which the drafting machine is fastened.

c. A slow-motion and braking mechanism is also contained within this bracket to allow for an accurate setting of the announced azimuth, and to keep the table from rotating when plotting upon it.

4. Functions.—*a.* The plotting board M5 is used by the flash ranging platoon of observation batteries of the Field Artillery.

b. It is used to determine the location of hostile batteries by plotting the flashes or smoke from their guns and is likewise used in conjunction with friendly batteries in high-burst ranging and center of impact adjustments for transfer of fire.

5. Limitations.—When the angle at the target for the two outside OP's is less than 250 mils, the board is used only as a check for locations computed from these two OP's.

SECTION III

OPERATION

6. Theory.—*a.* The theory of the plotting board M5 is basically simple, and the accuracy of the results obtained will depend to a large degree on the exactness of the operators.

b. If the base line OO' (fig. 2) is plotted on the grid disk and the azimuth of the target, as observed from each observation post, is laid off along the lines OT and $O'T$, the point of intersection of the two lines will be the true observed position of the target. The azimuth of T from any point can easily be determined by measuring the angle between the line connecting that point and T, and the grid north line; and the horizontal range of OT or $O'T$, or any other desired line, can readily be determined by scaling off the distances, using a straightedge graduated to the same scale as the grid disk. In practice, however, the XY coordinates of the point are the information usually desired.

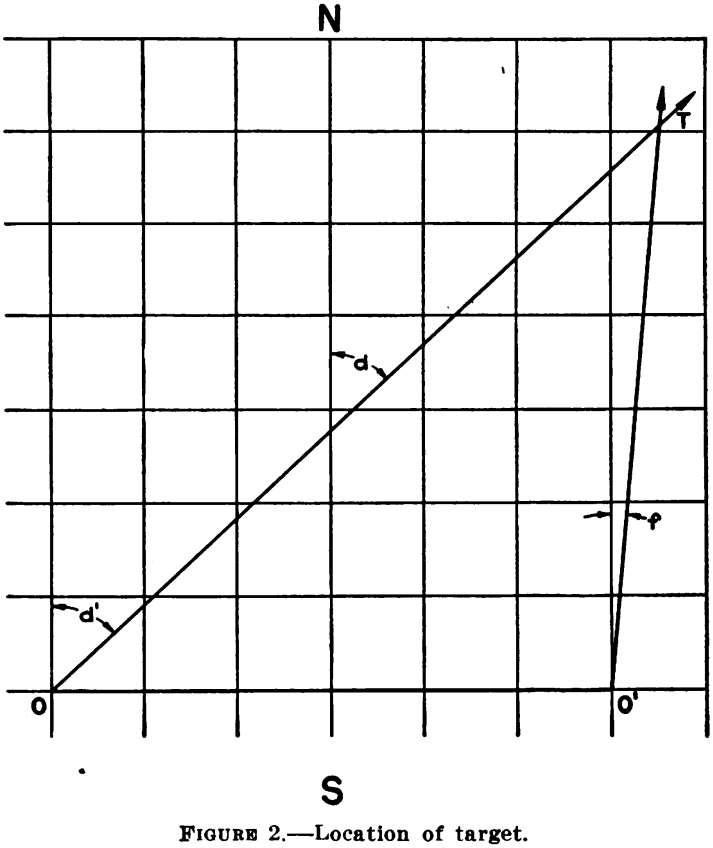

FIGURE 2.—Location of target.

c. In the grid system the azimuth of a line such as OT would be the angle d, that is, the horizontal angle measured in a clockwise direction from grid north. In figure 2, angle d' is equal to angle d as the Y-grid lines are all drawn parallel.

(1) Assuming that the straightedge could be swung in an arc of 180° and could be moved back and forth across the plotting surface, the azimuth of OT and $O'T$ could be easily laid off on the plotting surface. The azimuth of OT would be angle d' and that of $O'T$ would be angle f.

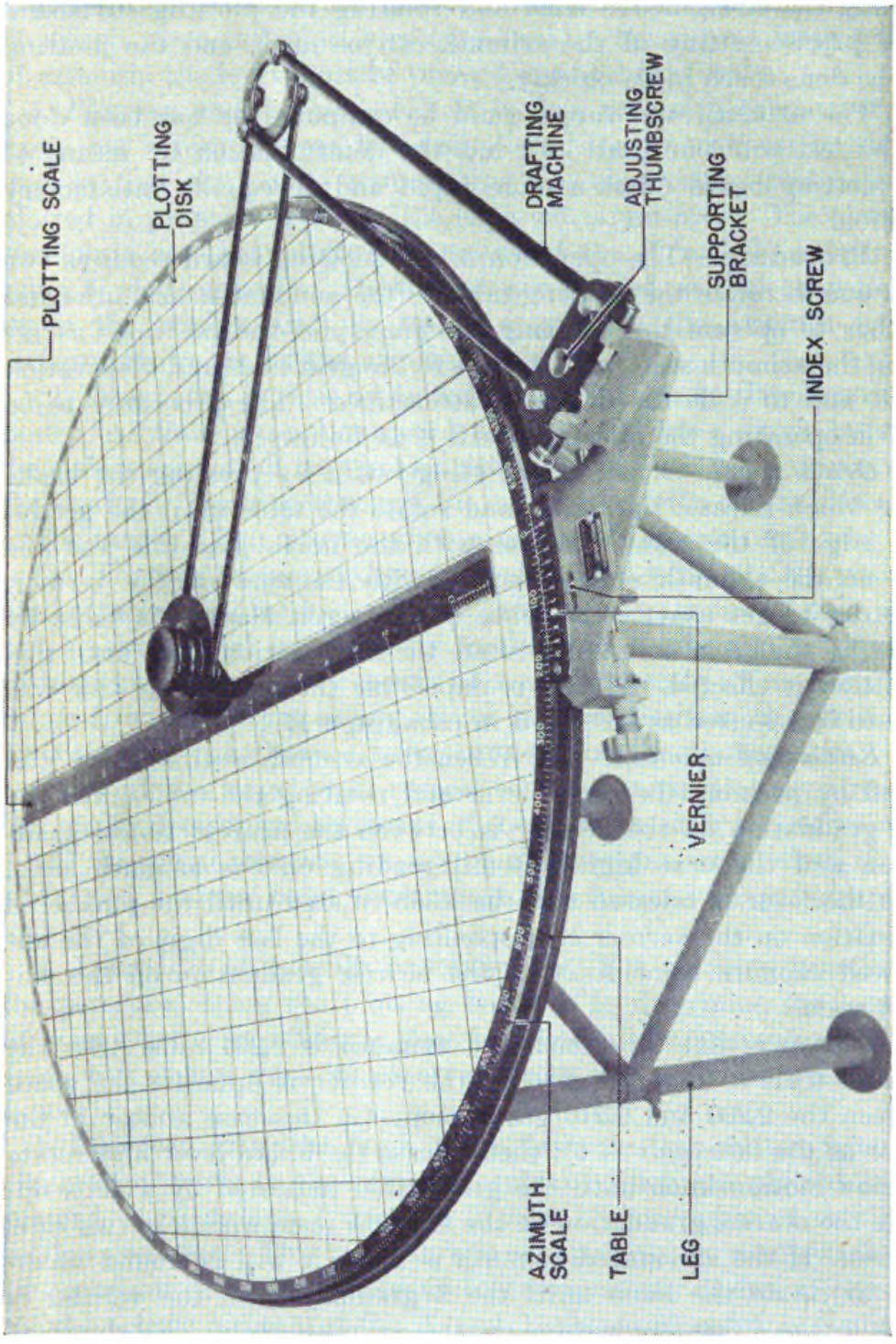

FIGURE 3.—Plotting board M5.

(2) The same results may be secured by using a plotting surface that can be turned through 360° or 6,400 mils, and a straightedge that is set in a fixed direction and can be moved back and forth across the plotting surface, remaining parallel to its original position. By

keeping the straightedge fixed and rotating the plotting surface, a more precise setting of the azimuth can be made and the plotting can be done much more quickly.

d. The azimuth and range could be computed as has been done in the test problem (par. 10), but the determination by means of the plotting board offers a more rapid and an equally satisfactory solution.

7. Procedure.—The operation of the plotting board requires two men, one to rotate the plotting table to the announced azimuths and another to operate the drafting machine, plot the positions as set off on the azimuth scale with respect to the grid lines and observation posts, and to scale the distances determined. The procedure to be used in operating the plotting board is as follows:

a. Orientation.—Orient the plotting board by pressing the brake lever which releases the brake, and rotate the table until the graduated edge of the scale coincides with the north grid-line and the zero on the azimuth scale coincides with the zero on the vernier. In order to get exact coincidence of the zeros, clamp the table by releasing the brake lever, and rotate the slow-motion knob until this condition is effected. If this is impossible the vernier or disk will have to be adjusted as described in paragraph 17.

b. Setting off azimuth.—(1) When the azimuth is announced it is set off by pressing the brake lever and rotating the table until the zero graduation on the vernier is between the nearest 10-mil graduation and the next higher 10-mil reading on the azimuth scale. Then the lever is released and the knob rotated until the numbered graduation on the vernier corresponding to the last digit of the announced azimuth coincides with the nearest graduation on the azimuth scale.

(2) Assume that the announced azimuth is 2,204 mils. Set the azimuth scale so that the zero on the vernier is opposite the space between the 2,200 and 2,210 graduations (in this case almost in the center as the last digit is 4), then release the brake lever and rotate the slow-motion knob until the graduation indicated by 4 falls opposite the nearest graduation on the azimuth scale which, in this case, is 2,280. If the announced azimuth is 2,208, it will be found necessary to rotate the knob until the 8 graduation on the vernier is opposite the 2,360 graduation on the azimuth scale. Readings to ½ mil can be set in a similar manner using the intermediate graduations on the vernier.

(3) When operating the slow-motion mechanism for vernier readings, the brake lever must always be released, leaving the brake en-

gaged, which is the normal position due to the action of the spring. However, when the table is rotated rapidly for approximate setting of azimuth, the lever must be pressed in and held firmly.

c. Plotting and scaling.—(1) It is first necessary to number the grids, but before this can be accomplished the set-up must be visualized so that the points representing the observation posts can be plotted in proper relation to the expected target area. The observation posts are then plotted by means of the X and Y coordinates using a plotting scale. These posts are plotted so that they lie between the vernier and the target area when the azimuth to the target area are set on the azimuth scale.

(2) The board is then ready for the azimuth from the observation posts. As these are announced from each OP for a single burst or flash they are set off on the azimuth scale and the rays drawn with the drafting machine through the respective OP's in the direction of the target. This process gives a group of intersecting lines.

(3) The intersection of these lines as plotted will mark the position of the target as observed. The X and Y coordinates of this point can be determined by referring to the grid origin and scaling the distances to each axis by means of a plotting scale. The horizontal range from the target to any OP or gun position can be determined by scaling off the distance, using the scale on the plotting arm. The azimuth of the target with respect to the gun position or directing OP can be determined by means of the azimuth scale and vernier.

(4) In actual practice, six sets of observations are plotted, if possible, and a mean point determined as explained in paragraphs 8 and 9.

8. Location of hostile batteries.—*a.* The primary function of the personnel using the plotting board is to determine the location of enemy batteries. This is done by plotting the azimuth of flashes from the enemy guns as observed from two or more observation posts.

b. Observed azimuths for a single flash are transmitted from the observation posts to the plotting central. They are plotted as explained in paragraph 7, and the X and Y coordinates of the intersection recorded. This procedure is repeated for as many flashes of the same gun as is practicable, up to a series of six flashes, if possible, at which time a mean of the X and Y values recorded is computed to give a mean center of flashes, and therefore, the observed location of the hostile battery.

9. High-burst ranging and center of impact adjustments.—The M5 plotting board is used in high burst ranging and center of

impact adjustments to locate the burst center and the center of impact of the group, respectively, for transfer of fire. The procedure is as follows:

a. The coordinates of the observation posts having been previously plotted, a rough plot of the expected check point is made from coordinates furnished by the firing battery commander if he has sufficient information to do so, otherwise a general area for observation is designated.

b. The azimuths to this point from each OP are determined by rotating the table until the plotting arm passes through the OP and the check point, and then reading the scale and vernier. These are transmitted to the individual OP's together with the approximate angle of site.

c. One round is fired and the azimuths are reported and plotted. The coordinates of this point are not recorded since it is plotted only as a check to see if each observer is sighting properly on the same burst. All OP's not seeing the burst are given its approximate azimuth (after it has been plotted) by the method prescribed in paragraph 9*b* so that the observers will not miss the succeeding rounds.

d. Six rounds are then fired and the azimuths of each burst are reported, plotted, and the coordinates recorded. The site of each shot is reported and recorded by the directing OP.

e. A running total of the X and Y coordinates of each burst is recorded and from this the X and Y coordinates of the mean center of bursts is computed and plotted.

f. The range of this point, the center of impact, is measured to the directing observation post.

g. The Z coordinate, which is the elevation of the point of burst, is calculated by the mil relation using the range and angle of site from the directing OP.

10. Test problem.—The following test problem (fig. 4) is given so that the operators may familiarize themselves with the board and check the accuracy of the results obtained.

a. The coordinates of the observation posts are given as follows:

$OP_1 X = 26,000.0 \quad Y = 10,000.0$
$OP_2 X = 22,300.0 \quad Y = 08,400.0$
$OP_3 X = 20,000.0 \quad Y = 10,000.0$
$OP_4 X = 21,300.0 \quad Y = 13,700.0$

b. Plot the various OP's and then lay off the azimuth through each OP. The azimuths are as follows:

OP_1= 84 mils
OP_2= 511 mils
OP_3= 836 mils
OP_4=1,167 mils

c. These lines should intersect at a point the coordinates of which are as follows:

X=26, 500.0; Y=16, 050. 0

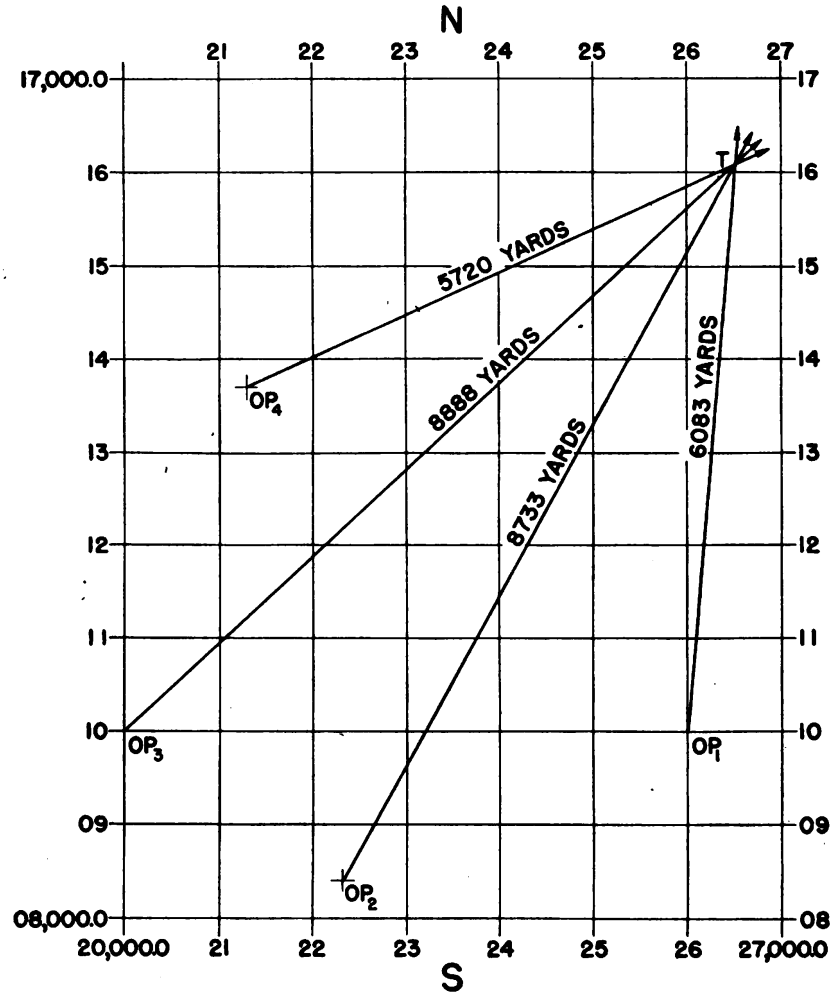

FIGURE 4.—Test problem.

d. The range as measured from each *OP* should be as follows:

OP_1=6,083 yards
OP_2=8,733 yards
OP_3=8,888 yards
OP_4=5,720 yards

SECTION IV

MAJOR UNITS

11. General.—*a.* The plotting board M5 consists principally of the rotating frame, referred to in this manual as the table, the support, the slow-motion and braking mechanism contained in the bracket which supports the drafting machine, and the drafting machine with the scale attached. An azimuth scale is engraved on the rim of the table.

b. The plotting surface or disk is set in the recess in the table and a vernier is attached to the bracket which is secured to the support.

c. The support is in turn supported by four legs that are braced to insure rigidity.

12. Table.—*a.* The table or frame (fig. 5) rotates on, and is supported by, the roller bearings which are attached to the support. It is centered about, and attached to, the spindle (A180868, fig. 5) which revolves in the ball bearing mounted in the support (D43480). The table also provides a seat for the plotting disk which is fastened to it by six screws.

b. An azimuth scale is engraved on the periphery of the top surface of the table. The scale is graduated into 640 equal spaces, each division representing 10 mils, and is numbered every 100 mils from 0 to 6,300 in a clockwise direction.

c. The plotting surface is an aluminum disk, which sits in the recess provided in the table. This disk has a grid so engraved on it as to conform with the standard fire-control grid so that the distance between the lines is 1.8 inches. A scale of 1/20,000 (1 yard= 20,000 yards) is normally used.

(1) The disk is sprayed on both sides with a synthetic cream enamel providing a surface upon which plotting can be done with a regular drawing pencil and the lines erased easily.

(2) The grid is engraved only on one side of the disk, however, permitting the plotting or drawing of special maps or grids on the other side to whatever scale desired. Six holes are counterbored alternately from each side of the disk.

13. Support.—*a.* The support (fig. 5) provides a seat for the bracket (D43480), supports the ball bearings on which the table

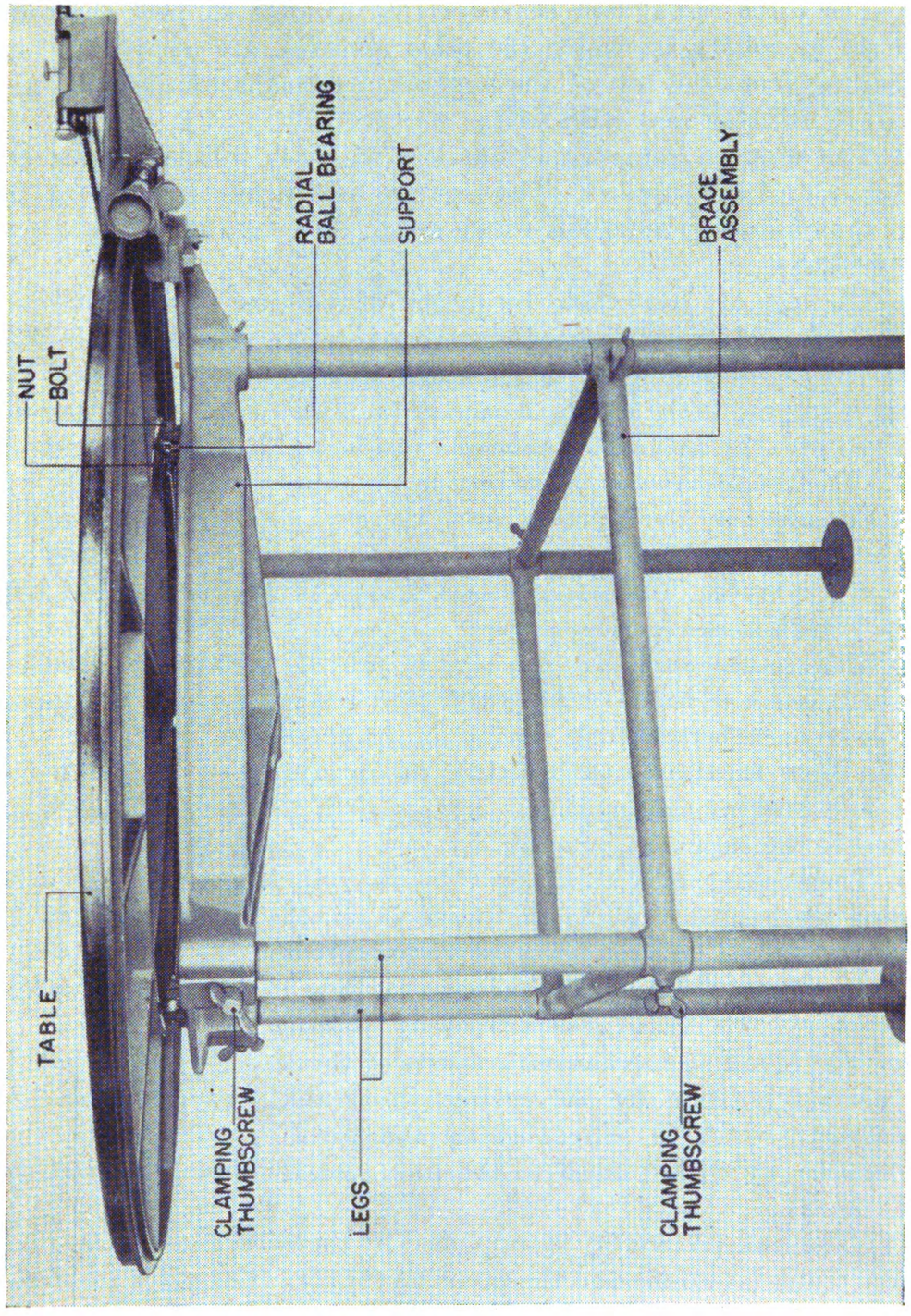

FIGURE 5.—Plotting board M5, side view.

rotates, and provides an internal bearing for the spindle (A180868) and a means of attachment for the legs.

b. The spindle revolves in the ball bearing housed in the center of the support and is held in place by the lock nut and washer (BBRX1AG and BEFX1AG).

c. The three radial ball bearings (fig. 6) that support the table and act as rollers, on which the table revolves, are secured in lugs extending from the top of the support, by means of the bolts and nuts (BCBX1BF and BBSX4B).

d. The support rests on the four legs which fit into sockets on the under side of the support. The legs are held firmly in place by the four thumbscrews (A180880) which are in turn secured by the screws (A180879A).

e. The legs are held rigid by means of a brace. This brace is a welded assembly consisting of four lengths of tubing welded to four small pieces of tubing through which the legs are inserted. The brace is secured to the legs by means of the four thumbscrews that are screwed into the boss on the tube and can be tightened up against the legs. The thumbscrews are retained in the tube by setscrews which fit into channels in the thumbscrews, thereby allowing only enough movement of the thumbscrews to permit clamping and freeing the legs in the brace. The setscrews are staked in position so that they cannot work loose.

f. Flanges are welded to the legs to provide a means of securing the instrument to the floor for permanent installation and to support the instrument better while resting on the ground.

14. Slow-motion and braking mechanism.—*a.* The slow-motion and braking mechanism is contained in the bracket that is attached to the support. (See fig. 7.)

b. The braking mechanism operates in conjunction with the slow-motion mechanism. When the brake is on, the flanged rim of the table is clamped between the shoe (A182950) and the slide (C77938, fig. 8). When the knob is rotated the slide moves along the lead screw carrying with it the shoe, thereby rotating the table.

c. The breaking mechanism consists of the lever, which is held in its normal position by the spring, the crank (A46736), the link (A180876) which is supported by the pivot (A46737), the shoe (A182950) which is pinned to the link, and the slide (C77938, sec. C–C fig. 8).

(1) The link (A180876) is supported by the slide and held in place by the crank (A46736) and the pivot (A46737). The pivot is secured by the collar (A46738) which is pinned to it. The brake lever is pinned to the crank (A46736), holding it in place.

(2) When the lever is pressed the crank rotates, lowering one end of the link a sufficient amount to release the clamping action of the shoe. Upon releasing the lever the spring forces the lever back to its normal position, which in turn clamps the table in position.

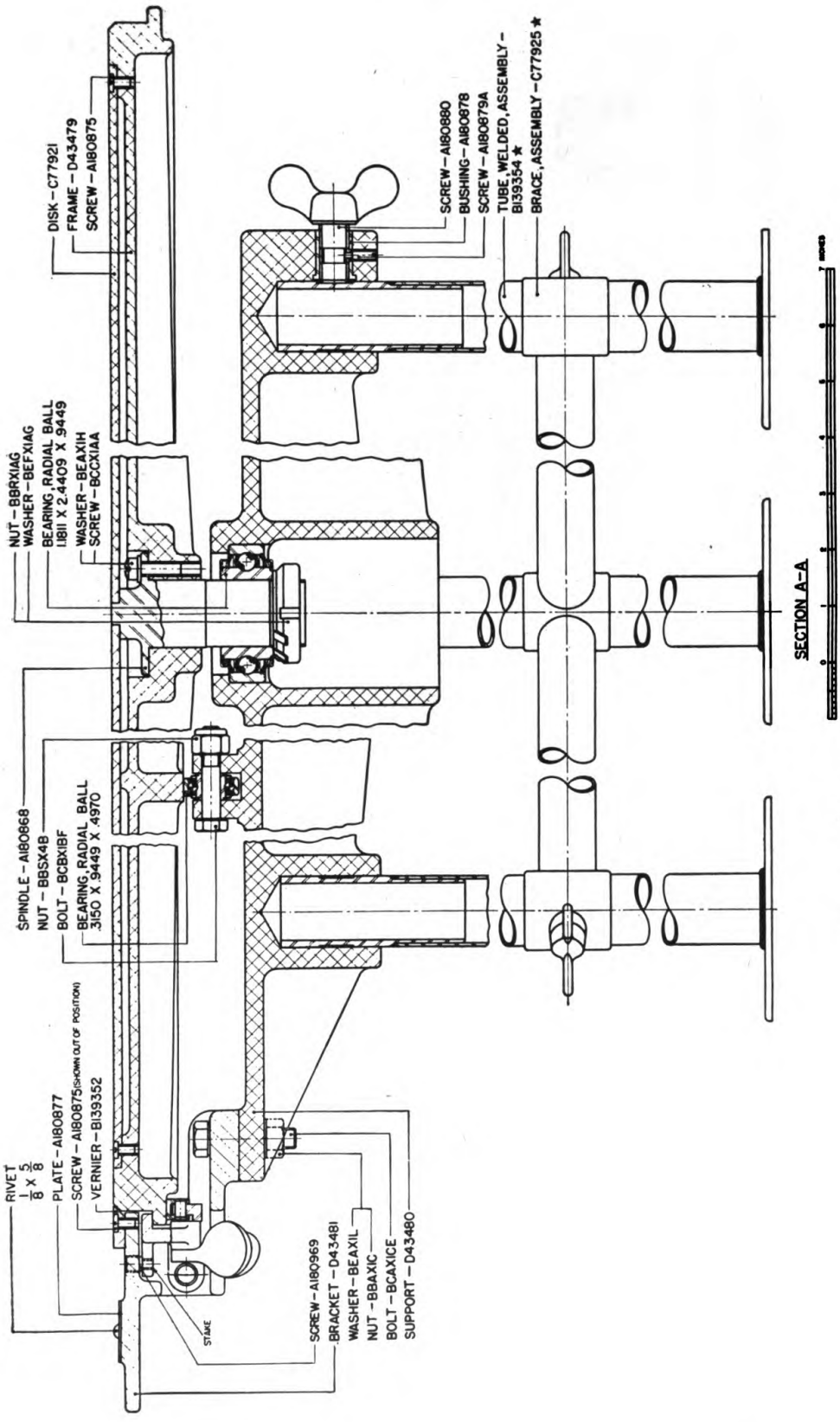

FIGURE 6.—Plotting board M5, sectional view.

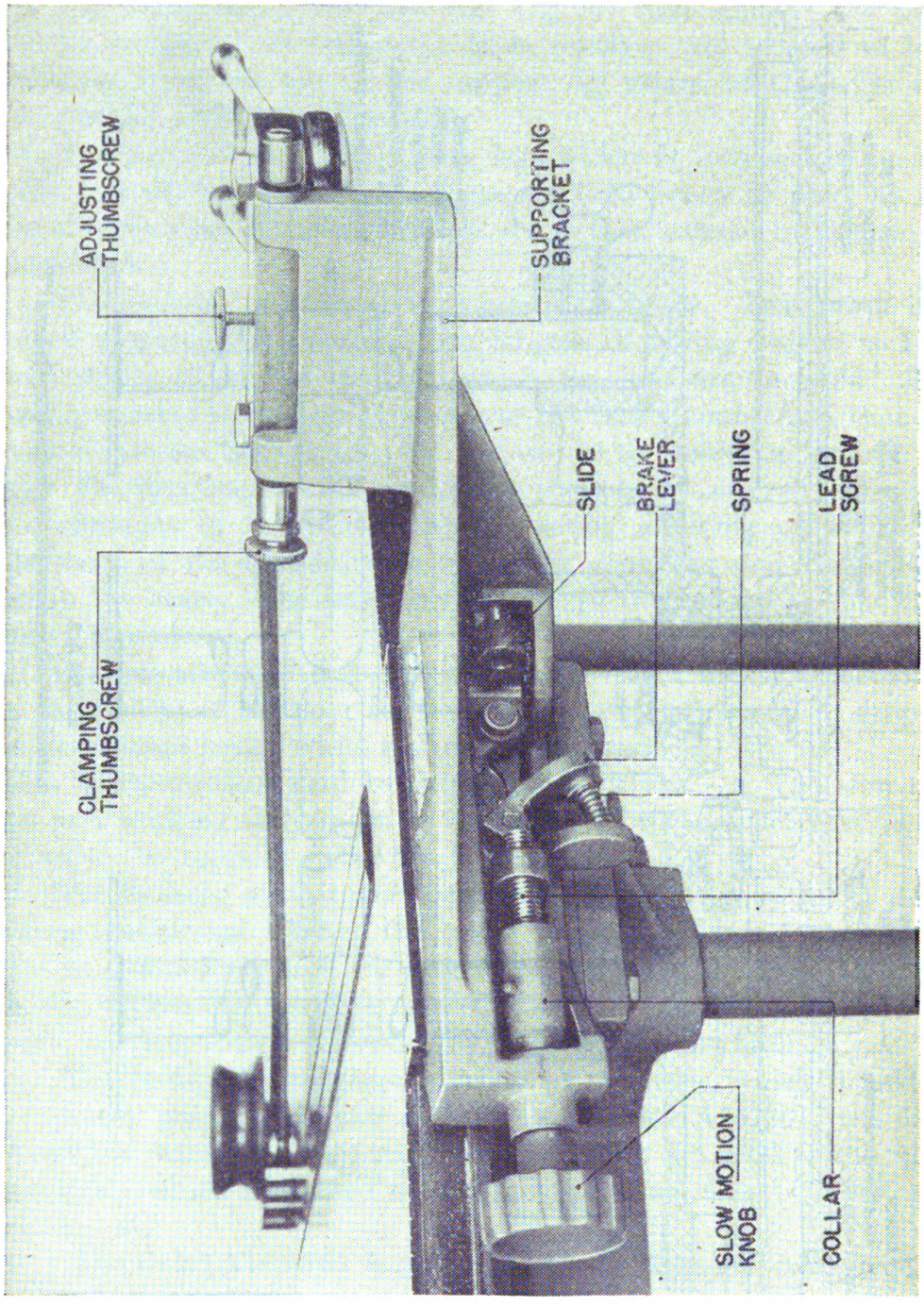

FIGURE 7.—Plotting board M5 slow-motion and braking mechanism.

d. The bracket provides seats for the vernier and name plate, bearings for the lead screw and the guide (A39476), and supports the drafting machine.

e. The lead screw is supported by one arm of the bracket and screws into the slide (C77938). The knob is pinned to the outside end of the screw to provide a means of rotation. The collar

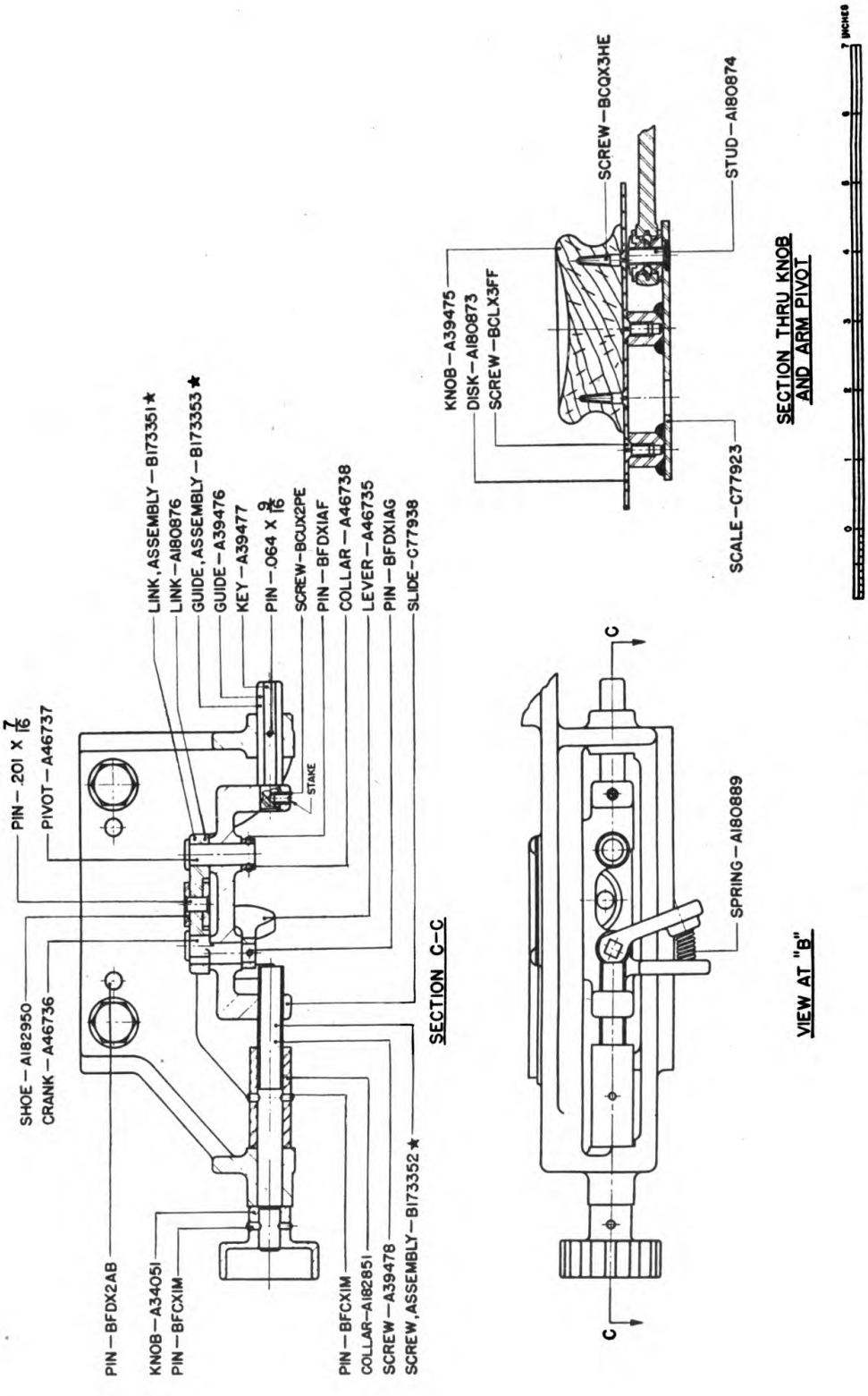

FIGURE 8.—Plotting board M5, sectional views.

(A182851) is pinned to the screw adjacent to the arm to take the thrust of the mechanism and is lengthened to act as a stop. Rotation of the knob provides the lateral motion of the slide along the screw.

f. The slide is positioned at the other end by the guide (A39476) that rides back and forth in the arm of the bracket. The guide fits into the slide and is secured by the screw (BCUX2PE) that screws into the guide through the slide. The key (A39477) is pinned to the guide (A39476) to prevent any rotating motion of the slide. The index screw staked in the upper part of the slide acts in the same capacity and also indicates the motion of the slide. (See fig. 3.)

g. The vernier is fastened to the top of the bracket by means of two screws through elongated holes. The vernier is graduated into 20 equal spaces, and numbered every second graduation from 0 to 10, permitting ½-mil settings when registering opposite the azimuth scale.

15. Drafting machine.—*a.* The drafting machine used on the plotting board M5 is a "Universal" drafting machine or equal, modified at the knob and arm pivot to receive the plotting scale. The machine is attached to the lugs extending from the top of the supporting bracket and tightened by means of a thumbscrew. The adjusting thumbscrew (fig. 7) provides a means of raising or lowering the machine so that the scale will lie flat on the plotting surface but will not bear too hard upon it.

b. The scale is attached to the pivoting arms of the drafting machine by the two studs (A180874, fig. 8). The disk (A180873) to which the knob is screwed is fastened to the scale by means of three screws (BCLX3FF).

c. The scale is graduated into 20 main divisions, each representing 1,000 yards, with the zero at the second graduation and numbered from 0 to 19. The first main division at the zero end of the scale is subdivided into 40 equal divisions, each representing 25 yards and numbered every fourth division from 1 to 10.

16. Accessories.—*a.* A packing chest (fig. 9) is provided for storage and shipping of the plotting board.

b. The only piece of equipment provided is a spanner wrench supplied with the drafting machine.

SECTION V

ADJUSTMENTS

17. Vernier.—*a.* To adjust the vernier—

(1) Rotate the table until the zero on the scale is approximately opposite the zero of the vernier and the central *Y*-grid line coincides with the edge of the plotting scale.

(2) Loosen the screws holding the vernier and move the vernier until the zero on the vernier is exactly opposite the zero on the azimuth scale.

(3) Tighten the screws.

b. If it is impossible to attain this position, the plotting disk may be out of adjustment. To adjust the disk—

(1) Loosen the six screws (A180875, fig. 6).

(2) Turn the disk.

(3) Tighten the screws.

(4) Readjust the vernier as explained in paragraph 17*a*.

18. Drafting machine.—The plotting scale may be riding too far off the plotting surface or it may be pressing too hard against the plotting surface. Correct this condition by means of the adjusting thumbscrew. Support the elbow of the drafting arm with one hand while making this adjustment.

SECTION VI

CARE AND PRESERVATION

19. Handling.—*a.* The plotting board M5 in general is not a delicate instrument, but care should be exercised in the handling of the drafting machine and the slow-motion and braking mechanism.

b. When setting up or disassembling the plotting board, care should be exercised to prevent bending, denting, or any other injury to the tubular arms of the drafting machine. This machine is properly assembled and lubricated at the factory. No adjustment in the field is necessary as the "Belleville" springs eliminate any looseness which may exist in the ball-bearing joints.

c. Avoid denting or chipping of the beveled edges of the scale and the surfaces of the plotting disk.

d. The slow-motion mechinism should be operated with care. If exposed to wet or damp weather at any time it should be thoroughly dried and the lead screw occasionally oiled with a thin coating of oil specified for this purpose to insure easy motion of the slide along the screw.

e. Pencils harder than 2H and gritty erasers should not be used on the plotting surface.

f. A sheet of vellum held in place by means of masking tape should be used whenever possible in order to preserve the plotting surface.

20. Storage and transportation.—*a.* When placing the instrument in the packing chest (fig. 9), place the brace assembly and legs in their respective spaces in the lower portion of the chest. Place the drafting machine, with the scale attached, in its supports in the lid. Place the main support, with table attached, in the chest, with the bracket in the position shown.

b. Be sure that the center joint, knob end, and free end of the drafting machine are placed in the stalls provided. Place the three hinged lids down over the locating blocks and fasten by means of the thumbscrews provided. The lid will then close properly and no damage to parts will be caused.

21. Precautions.—The following precautions should be taken when using the instrument and when storing it in the chest:

a. When using the instrument—

(1) Be sure that the plotting disk is fastened securely to the table. Tighten screws securing it to the table.

(2) Be sure that the drafting machine is securely fastened to the bracket. Tighten the thumbscrew provided.

(3) Be sure that the scale is fastened to the pivoting arms. Tighten studs (A180874, fig. 8).

(4) Be sure that the knob is fastened to the disk (A180873) and that the disk is securely attached to the plotting scale. Tighten screws (BCQX3HE and BCLX3FF).

(5) Never rotate the table without releasing the brake mechanism by means of the brake lever.

(6) Do not jam the slow-motion mechanism by rough usage of the slow-motion knob. The index screw indicates the movement of the slide on the lead screw.

(7) Be sure the legs are inserted firmly into the holes provided for them in the support and that the thumbscrews are tightened securely.

(8) Be sure that the brace is rigidly attached to the legs and that the thumbscrews are tightened sufficiently.

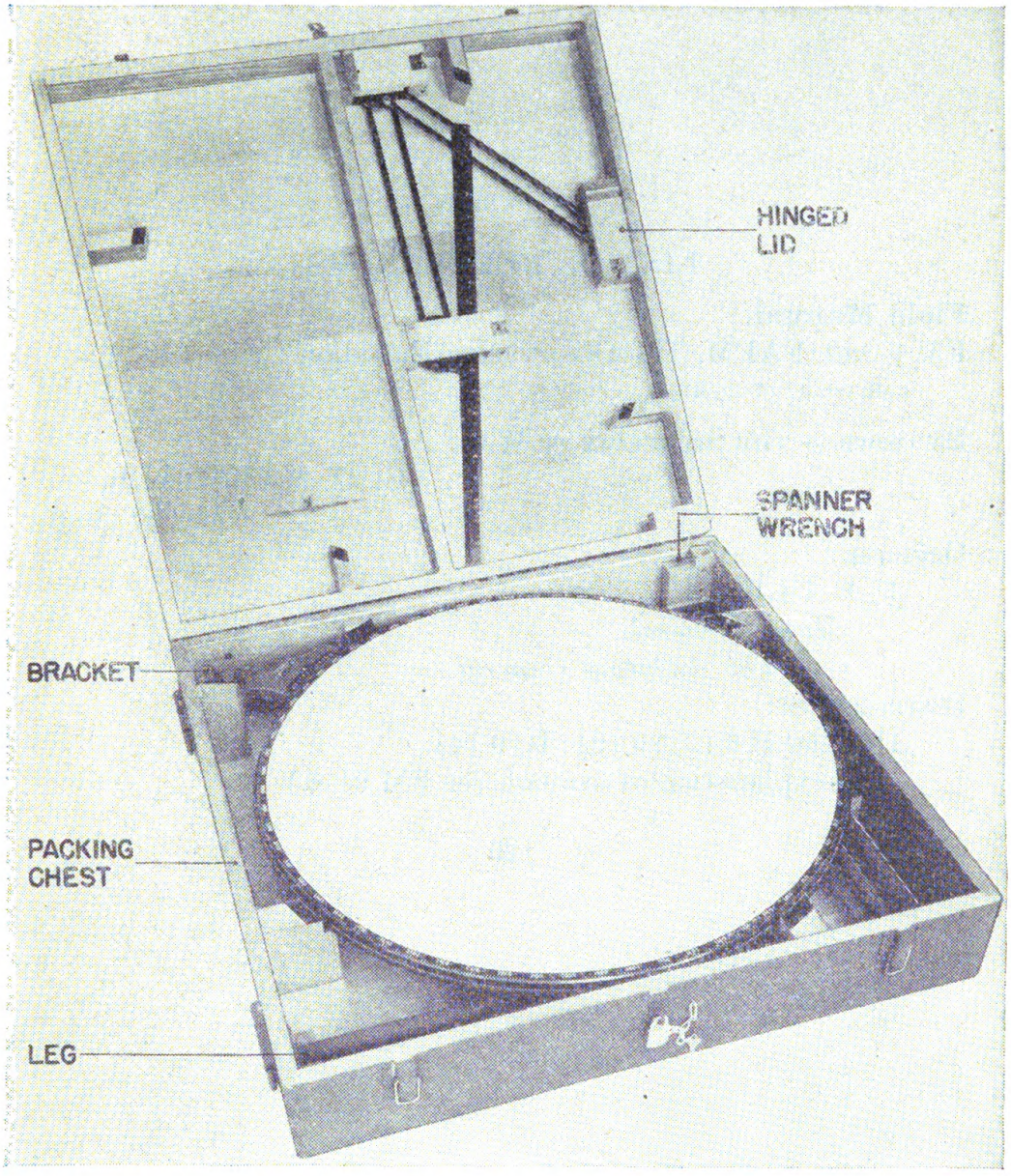

FIGURE 9.—Plotting board M5 in packing chest.

(9) Be sure that the bracket is securely fastened to the support. Tighten nuts (BBAX1C, fig. 6).

b. When storing the instrument in the chest—

(1) Do not attempt to close the lid without making sure that parts have been placed in their proper positions.

(2) Do not place any equipment in chest other than that which is required by the instrument.

APPENDIX

LIST OF REFERENCES

Field Manual.

FM 6–120, FAFM, The Observation Battalion.

[A. G. 062.11 (7–25–41).]

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(For explanation of symbols see FM 21–6.)

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